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ABSTRACT

Students undergoing a mastery-variable time-variable undergraduate educational psychology course were studied in order to determine the effects of level of mastery chosen (by the students for a final grade) on time taken to reach criterion level over five course examinations. When equated for trials to criterion, no such grade aspiration effect was found. A factor analysis of 23 course-related measures found time allowed for learning an important source of variation in a Mastery Learning teaching strategy, while academic aptitude was relatively unimportant. The study demonstrated how low-cost microcomputers can provide time flexibility in school curriculum. (Author/VT)

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Factors in Time-Variable Learning Allowed by Computer Delivered Interactive Testing

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Abstract

Students undergoing a mastery-variable time-variable undergraduate educational psychology course were studied in order to determine the effects of level of mastery chosen (final grade) on time to criterion over five course examinations. When equated for trials to criterion, no such grade aspiration effect was found. A factor analysis of 23 course-related measures found time allowed for learning an important source of variation in a Mastery Learning teaching strategy while academic aptitude was relatively unimportant. The study demonstrated how low-cost microcomputers can provide time flexibility in school curriculum.

Factors in Time-Variable Learning Allowed by

Computer Delivered Interactive Testing

Introduction

For a number of years researchers have expressed the importance of time allowed for learning as an important variable in explaining school achievement (Carroll, 1962; Glaser, 1967; Atkinson, 1967; Spady, 1977). Bloom (1976) has estimated that time, when combined with other such cognitive entry behaviors as intelligence and perseverance, may account for as much as 50 percent of the variation in school achievement. Traditional school learning shows great variation in student achievement when the time allowed for learning is fixed. This variation represents the individual differences which have been a problem for educators. If time allowed for learning is an important reason for these individual differences, one might conjecture that if it were allowed to vary in accordance with individual needs, some of the achievement variance would disappear.

Carroll (In Block, 1971) estimates that the ratio of slow-to-fast-learner time to criterion is about 5 to 1. He also suggests that this ratio can be diminished through sustained Mastery Learning teaching strategies. Anderson (1976) confirms this ratio, as well as its reducability.

In the present study, a Mastery Learning strategy was operating in an existing course. It attempted to isolate salient variables which would explain student activity. Microcomputer technology allowed time and trials to criterion to vary in a manner not allowed in other courses.

In this strategy, since mastery is fixed at three levels, there should be little variation in student achievement within each level; thus, it was hypothesized that fixed levels of mastery would allow great variation in time to criterion. If time to criterion were to be an important variable in explaining results of a college-level Mastery Learning strategy, then level of the criterion and trails to criterion should be important causes of this time variation. Academic aptitude should be a poor predictor of time to criterion, but a good predictor of achievement level in the Mastery Learning instructional strategy.

Method

Subjects

Forty-two students who completed an undergraduate liberal arts teacher education course were studied. Eight of the original class of 50 did not complete the course within the semester, and were dropped from the investigation. The group A.C.T. scores ranged from 13 to 31 with a mean of 22.83. Of the 42 students who completed the course in 107 days, 14 aspired to an "A", 22 to a "B", and six to a "C".

Procedure

The students were enrolled in a three semester hour educational psychology course using the Biehler (1974) text and five accompanying test item pools. During the 16 week semester, students spent one hour and fifteen minutes in class and three hours assigned to an elementary school classroom as a teacher aid. Class discussion topics followed text assignments, and students were required to make appointments for the five course examinations on their own time. Examinations were administered via a

cathode ray tube screen of an IBM 5100 portable computer. Each examination consisted of 15 multiple-choice questions randomly selected from one of the five item pools. If a choice was incorrect, the computer responded with "TRY AGAIN," and the question was presented again. This procedure would continue until a correct answer was chosen, when it would respond, "OK, SALLY, BUT BE SURE TO READ FEEDBACK FRAME." If Sally responded correctly on the first try, a random superlative would be presented, such as "EXCELLENT, SALLY." Examinations were scored with partial credit points on a 3-2-1-0 basis, depending on the number of choices required to get a correct answer. After 15 such iterations, scores were presented, with the criteria for letter grades of A-B-C-D being 90-80-70-60 percent, respectively. If students were not satisfied with their grades, they could see the instructor for aid, re-read the two or three chapters, and sign up for another randomly-selected set of questions from the item pool. Students could follow this procedure three times, if necessary, for each of the five examinations. This was the second full semester this treatment was utilized, and the procedure was only refined from that described in an earlier paper (Evans and Surkan, 1977), which examined achievement scores as a dependent variable.

Variables

Measures available for study included sex, age, A.C.T. Composite scores, the four 16PF Second Order Factor scores of Extraversion, Anxiety, Tough Poise, and Independence and final grade. Testing measures included trials to criterion, and highest raw score on each of the five course examinations.

Design

The research plan was to examine the effect of the three levels of final grade aspiration on days to criterion on each of the five examinations. Then, if significant effects were found, to study the relationship of trials to criterion with this variable. Finally, an exploratory study of the relationship among all 23 of the measures available was to be conducted. The .05 alpha level was chosen as the criterion for statistical significance.

Results

The ratio of highest to lowest number of days to criterion for each of the five examinations was, respectively, 3.45:1, 3.58:1, 3.03:1, 2.09:1, and 1.77:1.

Univariate analysis of variance of the three levels of final grade aspiration on time (days) to criterion revealed significant differences ($P < .01$) on examinations two through five. Figure 1 gives a plot of these mean score values.

Insert Figure 1 about here

Next, a comparison of the trials to criterion for each of these tests was obtained for each of the three levels of final grade.

Insert Table 1 about here

Table 1 presents the mean trials for each group. Although the mean total trials for each examination gives some indication of the relative difficulty of the five examinations these differences were not found to be important (Chi Square = 0.07, df = 4, n.s.). A test of the differences in total trials for each level of final grade was also unimportant (Chi Square = 5.43, df = 4, n.s.). Since trials was unrelated to grade, a reexamination of the effect of grade on days was conducted using trials as a covariate. Here, the significant differences among the means tended to disappear, with the differences among the three levels of grade remaining significant on only the second examination.

In order to observe the relationships of the foregoing variables with other measures available, intercorrelations are presented in Table 2.

Insert Table 2 about here

Here, it may be seen that final grade was negatively related to trials and days on four of the examinations, positively related to raw scores, and unrelated to A.C.T. aptitude test scores. The results of a factor analysis of these 23 measures is shown in Table 3.

Insert Table 3 about here

The findings of this analysis should be interpreted with caution since the number of cases is small. Seven factors appeared and are listed in their order of importance with tentative names.

Discussion

The ratios comparing days to criterion of slowest to fastest student on the five examinations are somewhat lower than that found by Anderson (1976), and there appears to be a distinct diminishment of this ratio as the course progressed. The lower overall ratio may be explained by the more homogeneous group allowed by the screening process of selecting candidates for teacher education in a private liberal arts college. It is tempting to explain the general diminishment in the ratio, from 3.58 to 1 on the first examination to 1.77 to 1 on the fifth as an alterable human characteristic due to the Mastery Learning teaching strategy in the manner of Anderson's findings. However, a problem without control in the present investigation was the subtle pressure of the registrar's office to turn in a grade at the end of the semester. This, along with the eight students who did not finish within the semester may have accounted for the greater homogeneity of the class in time to criterion on the last two examinations.

The relationship between level of final grade (A-B-C) and days to criterion seems logical. Students who aspired to the higher course achievement levels required less time than those whose aspirations were not so high. What is more difficult to explain is the addition of trials as a covariate in this analysis and its effect on minimizing these grade differences in days to criterion. This enjoins a search elsewhere for explanation of this time to criterion variance. The factor analysis may provide some clues. Time-related variables, as well as anxiety and independence, correlated highest with the second most important factor (II) in the factor analysis. The lack of a relationship between A.C.T. scores

and this factor is also noteworthy. Further investigation of this time variance should control for the foregoing personality characteristics.

While factor I accounted for nearly 40 percent of the total class variation, mostly due to the high relationships between raw scores on tests and final grade, this result is minimized when remembering that there were three levels of mastery in the course--required by the college's traditional letter grading system. As indicated above, this effect is minimized when controlling for grade aspiration and trials.

Factors III, IV, and V appear to be most related to the personality measures. Factor VI seems to be a "learning how to take interactive mastery tests" phenomenon, since it correlates highest with trials, days, and score on the first examination, and diminishes thereafter.

While the hypothesis concerning the effect of the three levels of mastery on time to criterion cannot be accepted due to the confounding effect of trials, it is possible to conclude that time is an important variable in school learning. The communalities (h^2) of the days-to-criterion variables are consistently among the highest of the 23 variables. This importance supports the notions of the Carroll "Model School Learning" (1962) and Bloom's "Mastery Learning" (In Block, 1971) that time allowed for learning varies according to individual human characteristics, and if schools really wish to maximize the achievement of all students, they must be able to adjust the time allowed for learning. The low-cost micro-computer used in the present study has possibilities for allowing students time flexibility in undertaking tasks when they are ready. The Carnegie

unit and the semester-hour of credit, both fixed units of time, do not allow students to transcend the bounds of the grading period or semester. The technology and process demonstrated in this study give an indication of how time-variable learning would be possible.

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Table 1

Mean trials to criterion of three levels

Of grade aspiration over five course examinations

Final grade	n	Examination 1	2	3	4	5	Total
A	14	1.79	1.36	1.93	2.00	1.43	8.50
B	22	1.77	2.09	2.14	1.86	1.55	9.41
C	6	2.33	1.83	2.17	2.00	2.00	10.33
Total	42	1.86	1.81	2.07	1.93	1.57	9.24

Table 2

Intercorrelations, Means, and Standard Deviation of 23 Course-Related Measures

Variable	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Sex	-.52	-.17	-.13	.03	.08	-.27	.00	.09	.13	.05	-.27	.29	.14
2. Age		.22	-.05	-.39	-.23	.46	-.17	-.12	-.18	.01	.12	-.18	-.22
3. ACT Score			-.19	.15	-.08	-.09	-.20	-.12	.30	-.09	-.08	.12	.08
4. Extraversion				-.32	.56	.13	.44	.02	-.16	.02	.23	.00	-.02
5. Anxiety					.06	-.26	-.04	.35	.14	-.05	.03	.04	.18
6. Tough Poise						.09	.18	.12	-.22	-.02	.44	-.06	-.06
7. Independence							-.17	-.06	-.14	.06	.38	-.24	.04
8. Trials, Test 1								.54	.02	-.10	.16	-.13	.09
9. Days, Test 1									.20	-.23	.12	.04	.01
10. Raw Score, Test 1										-.14	-.37	.38	-.10
11. Trials, Test 2											.36	-.26	.22
12. Days, Test 2												-.62	.17
13. Raw Score, Test 2													-.15
14. Trials, Test 3													
15. Days, Test 3													
16. Raw Score, Test 3													
17. Trials, Test 4													
18. Days, Test 4													
19. Raw Score, Test 4													
20. Trials, Test 5													
21. Days, Test 5													
22. Raw Score, Test 5													
23. Final Grade													

Table 2

(continued)

Variable	15	16	17	18	19	20	21	22	23	M	SD
1. Sex	-.07	.27	.11	-.33	.28	-.12	-.47	.40	.40	--	--
2. Age	.01	-.36	-.10	.19	-.29	.13	.30	-.27	-.32	19.90	1.56
3. ACT Score	.02	.01	-.07	.16	-.09	-.10	.30	.07	.00	22.83	4.61
4. Extraversion	-.09	.08	-.14	-.24	.16	.00	-.17	.01	.01	5.42	1.90
5. Anxiety	.31	.02	-.03	.26	-.06	.10	.29	-.08	-.09	5.34	2.07
6. Tough Poise	.10	.30	-.18	-.10	.26	.00	.06	.14	.14	5.07	1.71
7. Independence	.35	-.11	-.10	.18	-.02	.30	.32	-.31	-.17	5.78	1.52
8. Trials, Test 1	-.11	.07	.17	-.14	.02	.00	-.21	-.01	-.06	2.00	.91
9. Days, Test 1	.02	.21	.17	.02	.09	-.15	-.04	-.06	.11	31.67	17.92
10. Raw Score, Test 1	-.21	.30	-.11	-.11	.17	-.41	-.27	.07	.44	41.33	2.22
11. Trials, Test 2	.06	-.07	.08	.20	-.25	.22	.19	-.01	-.30	1.83	.79
12. Days, Test 2	.59	-.11	-.09	.52	-.21	.37	.60	-.36	-.48	46.80	17.33
13. Raw Score, Test 2	-.48	.26	.23	-.38	.40	-.38	-.47	.59	.67	41.10	3.24
14. Trials, Test 3	.42	-.14	.31	.41	-.18	.33	.31	-.13	-.24	2.07	.87
15. Days, Test 3		.23	-.33	.79	-.42	.20	.67	-.46	-.53	67.13	19.41
16. Raw Score, Test 3			.01	-.39	.63	-.01	-.43	.53	.77	40.30	3.20
17. Trials, Test 4				-.07	.23	.34	-.05	.22	.17	1.93	.91
18. Days, Test 4					-.50	.07	.81	-.50	-.59	82.63	16.80
19. Raw Score, Test 4						-.07	-.50	.45	.72	39.80	3.27
20. Trials, Test 5							.33	-.16	-.28	1.63	.81
21. Days, Test 5								-.46	-.64	93.87	14.98
22. Raw Score, Test 5									.70	40.83	2.88
23. Final Grade										3.37	.61

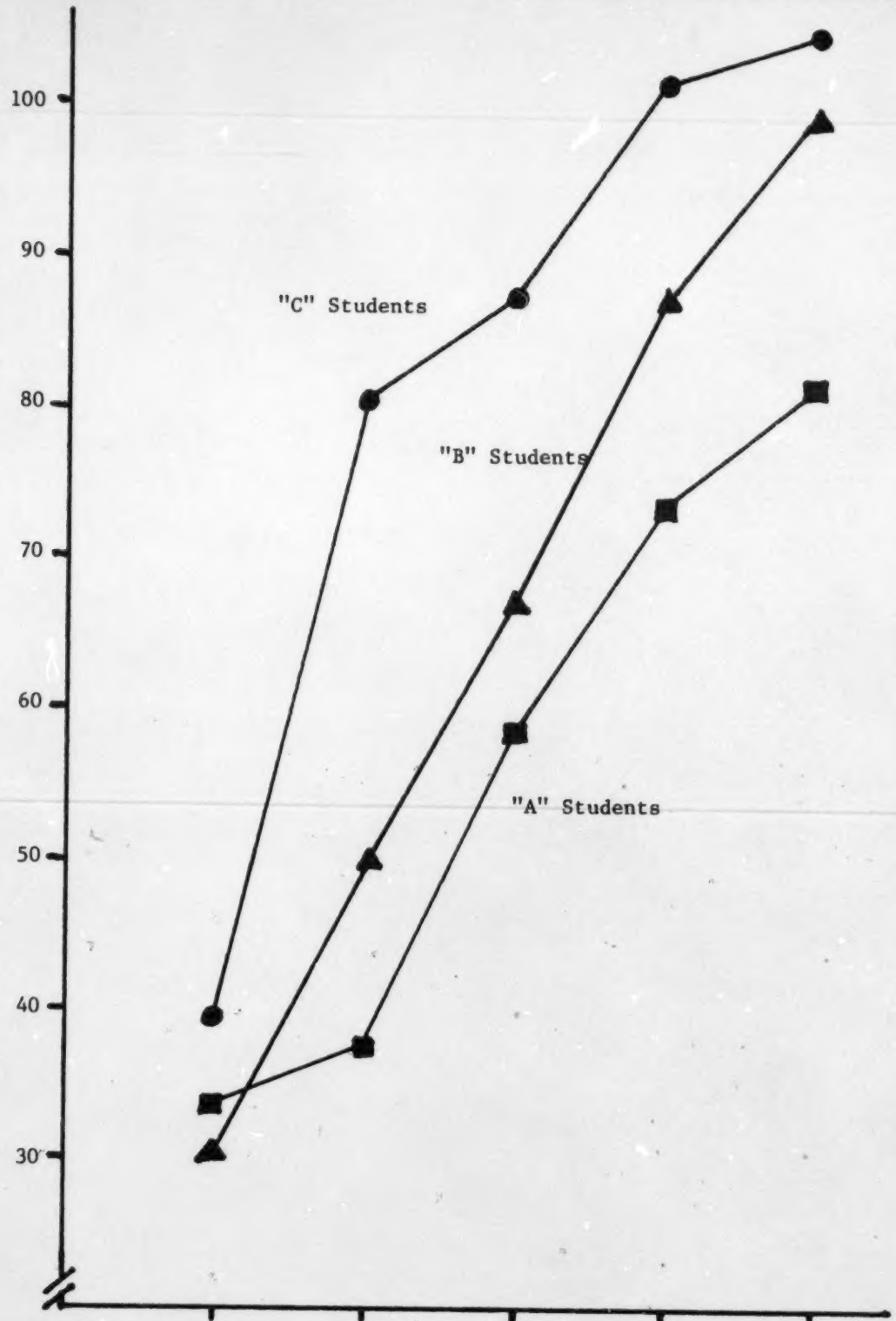
Table 3

Varimax Rotated Factor Matrix of twenty-three course-related variables

Variable	Factor I "Mastery"	II "Time"	III "Toughness"	IV "Perseverance"	V "Dependence"	VI "Naivete"	VII "Aptitude"	h^2
Sex	.36	-.05	-.14	.03	.56	-.08	-.36	.60
Age	-.29	-.07	-.09	-.02	.76	-.10	.11	.71
A.C.T.	.02	.04	-.13	-.10	-.01	-.09	.59	.39
Extraversion	.01	-.16	.74	-.05	-.10	.11	-.16	.62
Anxiety	.02	.39	-.17	.02	.41	.24	.29	.49
Tough Pois.	.29	.22	.77	-.04	.09	.02	.01	.74
Independence	.04	.35	.06	.10	-.65	-.09	-.16	.59
Trials 1	-.12	-.17	.37	.09	.13	.67	-.18	.69
Days 1	.13	.14	-.01	-.05	.08	.85	-.03	.77
Score 1	.27	-.09	-.30	-.38	.13	.20	.20	.41
Trials 2	-.19	.11	.10	.31	.07	-.25	-.08	.23
Days 2	-.20	.62	.49	.29	-.21	.06	-.03	.79
Score 2	.48	-.44	-.20	-.16	.20	.01	.23	.58
Trials 3	-.14	.30	-.07	.46	.27	.03	.05	.40
Days 3	-.28	.90	.01	.02	.04	-.05	-.01	.88
Score 3	.79	.00	.14	-.06	.12	.09	-.04	.66
Trials 4	.16	-.30	-.20	.74	.05	.24	.07	.77
Days 4	-.44	.65	-.11	.13	-.05	.01	.32	.76
Score 4	.75	.21	.11	.01	.01	.07	-.09	.63
Trials 5	-.04	.22	.05	.67	-.20	-.09	-.12	.57
Days 5	-.41	.64	.04	.27	-.22	-.07	.50	.95
Score 5	.58	-.40	.07	.06	.28	-.15	.10	.62
Grade	.91	-.32	-.08	-.17	.11	.04	.02	.99
Eigenvalue	5.85	2.27	1.99	1.50	1.40	1.09	.72	
Percent Variance	39.50	15.30	13.40	10.10	9.40	7.40	4.90	

Figure Caption

Figure 1. Days to criterion according to three levels of grade achievement over analysis of variance results.



Test:	1	2	3	4	5
Grade effect	n.s.	$p < .01$	$p < .01$	$p < .01$	$p < .01$
GE with covariate (Trials)	n.s	$p < .02$	n.s	n.s	n.s